A/NO-Fee

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Assistant Commissioner for Patents
Washington, D.C. 20231

Attorney Docket: P54562

Sir:

Submitted herewith is the following patent application:

Inventor: **Chun-Geun CHOI**

Title: **COLOR CURVE CONTROL CIRCUIT AND METHOD**

Please find attached hereto an application for patent which includes: Specification and Abstract, Claims, original Declaration And Power of Attorney, Assignment, and a certified copy of the foreign priority document identified below:

Verified Showing of Small Entity Status: No

Drawings: Formal drawings, 3 sheets, Figures 1 through 3

Claim of priority under 35 U.S.C. §119: **YES**
**REPUBLIC OF KOREA Application No. 96-20847 filed on 11 June 1996

Fee (see formula below): CHECK IS **NOT** ENCLOSED

Basic Fee $385/770	$770.00
Additional Fees:	
Total number of claims in excess of 20 0 times $11/22 .	$0.00
Number of independent claims in excess of 3: 0 times $40/80	$0.00
Multiple Dependent Claims $130/260	$0.00
An Assignment is likewise enclosed: Recording Fee $40 . .	$0.00
Filing Non-English specification	$ 0.00
TOTAL FEES FOR THE ABOVE APPLICATION	*$770.00*

Inventor: **Chun-Geun CHOI**

Title: **COLOR CURVE CONTROL CIRCUIT AND METHOD**

In view of the above, it is requested that this application be accorded a filing date pursuant to 37 CFR 1.53(b).

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Respectfully submitted,

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REB/mf

TITLE

COLOR CURVE CONTROL CIRCUIT AND METHOD

CLAIM OF PRIORITY

This application makes reference to, incorporates the same herein, and claims all benefits accruing under 35 U.S.C. §119 from an application entitled *Color Curve Control Circuit And Method* earlier filed in the Korean Industrial Property Office on 11 June 1996, and there duly assigned Serial No. 20847/1996 by that Office.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a color curve control circuit and method. Specifically, this invention easily adjusts the colors as desired by the user, on the screen of a monitor using color gain and cutoff signals corresponding to the color temperature.

Discussion of Related Art

Red does not indicate just one color. There are many variant colors from a red similar to orange to purplish red. There are also variant colors such as yellowish white and bluish white in white resulting from mixing red (R), green (G), and blue (B). Therefore, it is necessary to define the desirable three primary colors of light, R, G, and B, and standard white. The standard colors are employed by Commission International de L'Eclairage (CIE), and represented with R, G, B, and white points of light.

CIE defines the three primary colors according to wavelengths, thus light of 700nm is defined as R, the light of 546nm is defined as G, and the light of 435nm is defined as B. CIE uses color matching where mix ratios of the three primary colors are calculated using a color matching measurement device to obtain various colors, thus colors are created by mixing the three colors according to calculated ratios.

Since human eyes sense colors differently and individually, and since they are most sensitive to the light near 550nm, there are large perceived differences between R, G, B when the intensities of the three primary colors are represented by the absolute lumen or watt values. In color matching, a standard white is defined as the amount of R, G, and B which is necessary to match the standard white, and the amount of white, that is R + G + B, is set to 1. The amounts of R, G, and B is represented with a ratio to the white. For example, a color of 600nm is made by mixing 0.34 of R, which is necessary to make the standard white, with 0.07 of G, which is also necessary to make the standard white. Such a mixing method is called a tristimulus value. An example is given below to demonstrate a conventional color mix method using this tristimulus value.

People react differently to colors. The same color can be perceived differently by different people. Therefore, colors are very important to a user who uses a monitor while working.

For example, when G and B are reduced from the value of a 9300°K white, the R value becomes relatively large and reddish colors are displayed. The user can utilize different standard white value in the manner that he/she stores different standard white values in memory and selects from them. For this, monitor manufacturers provide several limited colors, or values, which are most frequently utilized by the users. High quality monitors are designed so that the users can adjust the

colors, but inaccurate color values are utilized because they must select them depending on their own eyes.

The values supplied to users are abstract virtual color values, not the color values which appear actual color characteristics. When some software applications requiring more precise colors need a white value for the monitor, the users can only utilize the colors which are set during manufacture because they cannot know the white value of the monitor. Therefore, it is difficult for the users to adjust colors to particular values, and it takes much time. It is also a problem that the users cannot utilize a color adjustment function even though the monitor has this function.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a color curve control circuit and method that substantially obviates one or more of the limitations and disadvantages of the related art.

An object of the present invention is to improve a color function which enables users to adjust colors to the state they want in a monitor, by adjusting colors displayed on a monitor using the R, G, and B gain and cutoff signals which change according to the color curve in color space.

To achieve these and other advantages, and in accordance with the purpose of the present invention as embodied and broadly described, a color curve control circuit utilizes a data input unit, for entering values to adjust colors on the screen of a monitor, a microcomputer, for processing color signals corresponding to color temperature using stored color temperature data according to a color curve control program in order to change the colors on the screen according to signals generated by the data input unit, and for generating color gain signals and color cutoff signals, and a digital to

analog converter for converting the digital color gain and cutoff signals from the microcomputer into analog signals.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed. Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure as illustrated in the written description and claims hereof, as well as the appended drawings.

BRIEF DESCRIPTION OF THE ATTACHED DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention that together with the description serve to explain the principles of the invention. In the drawings:

Fig. 1 is a circuit diagram of a color curve control circuit according to the principles of the present invention;

Fig. 2 is a graph showing a color curve corresponding to temperature; and

Fig. 3 is a flow chart for controlling the color curve according to the principles of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

As shown in Fig. 1, a data input unit 10 includes a temperature sensing unit 11 for generating a temperature signal corresponding to the ambient temperature of the monitor, and a keypad 12 through which users selects an automatic mode or manual mode of operation and inputs color temperature values during the manual mode of operation. A microcomputer 20 receives the ambient temperature generated by temperature sensing unit 11 or the color temperature signals generated by keypad 12, converts the temperature signal into a digital signal, and processes data corresponding to the temperature signals using stored color temperature data and a color curve control program. A digital-to-analog converter (D/A converter) 30 receives digital R, G and B video gain and cutoff signals corresponding to the temperature signals from microcomputer 20, and converts the digital signals into analog signals. An on screen display (OSD) unit 40 processes OSD data which is serially transmitted from microcomputer 20, to display R, G and B OSD signals on the screen for the users. A video pre-amplifying unit 50 amplifies R, G and B video signals generated by a computer graphic adaptor (not shown) according to the levels of the R, G and B gain signals transmitted by D/A converter 30. A multiplexer 60 selects either the R, G and B video signals from video pre-amplifier 50 or the R, G and B OSD signals from OSD unit 40 in response to an enable signal OSD_EN. A video main-amplifying unit 70 amplifies the R, G and B video signal or the R, G and B OSD signals, transmitted by multiplexer 60, according to the R, G and B cutoff levels generated by D/A converter 30. A cathode-ray tube (CRT) 80 produces beams in response to the amplified R, G and B signals output by video main-amplifying unit 70, through R, G and B cathodes to display the signals.

The operation of the above circuit is now described. The ambient temperature of the monitor is sensed by the temperature sensor of temperature sensing unit 11 in data input unit 10. Since an ambient temperature signal generated by temperature sensing unit 11 is weak, it is amplified by an operational amplifier OP1 and then transmitted to microcomputer 20. Additionally, color temperature signals, selected by a user using keypad 12 of data input unit 10 during a manual mode, are input to microcomputer 20.

Microcomputer 20 generates color gain signals corresponding to the amplified ambient temperature or selected color temperature signals transmitted by temperature sensing unit 11 and keypad 12, respectively. The process by which microcomputer 20 generates the color gain signals is as follows.

The temperature signals generated by temperature sensing unit 11 are analog signals. When a user selects an automatic mode of operation using keypad 12, microcomputer 20 receives these analog temperature signals and converts them into digital signals. When a user selects a manual mode of operation using keypad 12, the user selects a color temperature using keypad 12, and keypad 12 generates a color temperature signal corresponding to the selected color temperature, and transmits it to microcomputer 20. Microcomputer 20 generates the R, G and B gain and cutoff signals, according to the selected operation mode, corresponding to the ambient temperature signal or color temperature signal using a color curve control program to read from stored color temperature data.

Microcomputer 20, which generates R, G and B gain and cutoff signals corresponding to the ambient temperature signal or color temperature signal, confirms information on colors to be

illustrated on a screen as a result of processing the R, G and B gain and cutoff signals. Microcomputer 20 also generates OSD values, which includes information on the color temperature signal selected by the user or the ambient temperature sensed by temperature sensing unit 11, for transmission to OSD unit 40 to be displayed and viewed by the user. The R, G and B gain and cutoff signals generated by microcomputer 20 are transmitted to D/A converter 40 through a serial connection.

The R, G and B gain and cutoff signals generated by microcomputer 20 are digital signals. These digital R, G and B gain and cutoff signals are converted into analog signals by D/A converter 30, then transmitted to video pre-amplifying unit 50 and video main-amplifying unit 70, respectively.

OSD unit 40 receives the OSD data for displaying characters representing the sensed ambient temperature by temperature sensing unit 11 or the color temperature selected by a user through keypad 12. OSD unit 40 also receives horizontal and vertical sync signals transmitted through a computer graphic adaptor (not shown). The data which is input to OSD unit 40, is generated as signals R_OSD, G_OSD, B_OSD, and OSD_EN in synchronization with the horizontal and vertical sync signals from the graphic adaptor. The signals generated by OSD unit 40 are transmitted to multiplexer 60. This operation of displaying the information and color signals from microcomputer 20 on the screen of the monitor, is described below.

The R, G and B gain signals (R_Gain, G_Gain, B_Gain) generated by microcomputer 20 are converted into analog signals by D/A converter 30. The analog R, G and B gain signals (R_Gain, G_Gain, B_Gain) and R, G and B video signals from the computer graphic adaptor are transmitted

to video pre-amplifying unit 50. R video and R gain signals are supplied to operational amplifier OP2, G video and G gain signals are supplied to operational amplifier OP3, and B video and B gain signals are supplied to the operational amplifier OP4.

The R, G and B video signals, which are supplied to each operational amplifier of video pre-amplifying unit 50, are amplified to the levels of the R, G and B gain signals. The R, G and B video signals, amplified by video pre-amplifying unit 50, are transmitted to multiplexer 60. Multiplexer 60 receives signals OSD_R, OSD_G, OSD_B, and OSD_EN from OSD unit 40 with the pre-amplified R, G and B video signals. R video signal and signal OSD_R are supplied to operational amplifier OP5, G video signal and signal OSD_G are supplied to operational amplifier OP6, and B video signal and signal OSD_B are supplied to operational amplifier OP7.

The R, G and B video signals or the OSD signals, R_OSD, G_OSD, and B_OSD, of operational amplifiers OP5-OP7 are transmitted to video main-amplifying unit 70 in response to signal OSD_EN. At this time, only when multiplexer 60 is turned ON by OSD_EN, are the OSD signals, OSD_R, OSD_G, and OSD_B, transmitted from the operational amplifiers of multiplexer 60 to video main-amplifying unit 70. The OSD_EN signal is generated only when the automatic or manual color correction modes are selected by the user using keypad 12, at all other times the R,G and B video signals output from the computer graphic adaptor is displayed according to the current R, G and B gain and cutoff signals applied to amplifiers 50 and 70, respectively.

Video main-amplifying unit 70 receives the R, G and B video or OSD signals selected according to the signal OSD_EN, and R, G and B cutoff signals generated by D/A converter 30. R video or R_OSD, and R_Cutoff signals are supplied to operational amplifier OP8, G video or

G_OSD, and G_Cutoff signals are supplied to operational amplifier OP9, and B video or B_OSD, and B_Cutoff signals are supplied to operational amplifier OP10 in video main-amplifying unit 70. The R, G and B video or OSD signals, which are transmitted to operational amplifiers OP8-OP10 of video main-amplifying unit 70, are amplified according to the levels of the color cutoff signals (R_Cutoff, G_Cutoff, B_Cutoff), transmitted by D/A converter 30. The amplified signals are sent to corresponding cathodes R (R.K), G (G.K) and B (B.K) for display on the screen of the monitor through CRT 80.

A general color theory about displaying colors the users want using ambient temperature signals or selected color temperature signals is described below with reference to the attached drawings.

Fig. 2 is a graph illustrating a color curve according to temperature. The arrows centered around the origin O represent R, G and B. The oval around the origin O represents the area of white. The curved line between points b and r represents color temperature in Kelvin, herein the temperature of point b is 9300°K, and the temperature of point r is 5000°K. The following is a detailed description of this graph.

A way of displaying colors in a monitor is explained through a color reduction method using R, G and B. It is widely known that maximum R, G and B create a white. The range of colors recognized by human beings as being white is wide. The Kelvin color temperature scale is utilized to standardize colors in this wide color range. As the color temperature increases, colors become close to blue (point b), whereas colors approach red (point r) as the temperature decreases. Therefore, color signals corresponding to temperature can be controlled by changing the R, G and B mix ratio.

A color adjustment method using a color curve is explained with reference to the attached drawings.

As shown in Fig. 3, a range of temperatures (T_len) is established according to T_MIN and T_MAX in factory mode during manufacture (step S91). When the range of temperatures, T_len, is established, R, G and B gain and cutoff values corresponding to the respective T_MIN and T_MAX are produced (step S92). The R, G and B gain and cutoff data corresponding to the range of temperature, T_len, is stored (step S93). A user selects a color correction mode as one of an automatic mode and a manual mode (step S94). The sensed ambient temperature is detected by microprocessor 20 to be compared to the stored values (step S95), when the automatic mode is selected in step S94. A color temperature value is entered by a user to be compared to the stored values (step S96) when the manual mode is selected in step S94. R, G and B gain and cutoff values corresponding to the temperature range, T_len, are read (step S97) following steps S95 or S96.

The more detailed description of this procedure is set forth in the followings.

When establishing the temperature range, T_len, in the factory mode during manufacture, the temperature range is defined with minimum and maximum Kelvin temperatures. When the minimum and maximum temperatures are established in the factory mode, their coordinates are calculated (step S91). At step S92, R, G and B gain and cutoff values corresponding to the minimum and maximum temperatures, T_MIN and T_MAX, are calculated. For example, when the minimum temperature T_MIN is set at 5000°K, coordinates corresponding to 5000°K are calculated. When the maximum temperature T_MAX is set at 9300°K, coordinates corresponding to 9300°K are calculated. R, G and B gain and cutoff values corresponding to the temperature range between minimum and maximum temperatures T_MIN and T_MAX, is generated using these coordinates.

Additionally, a color curve value S, which effects the properties of the curve, is a value fixed during manufacture according to CRT properties. When the calculated R, G and B gain and cutoff data corresponding to the temperature range between minimum and maximum temperatures, T_MIN and T_MAX, are stored at step S93, the operation in a factory mode is completed. When the calculated values are stored at step S93, a temperature is entered according to either a sensed ambient temperature or by the user at steps S95 and S96, respectively, as discussed above following selection of either an automatic or manual mode of color correction in step S94. Then, the R, G and B gain and cutoff values corresponding to the temperature range, T_len, are read (step S97) following steps S95 or S96.

Coordinates xc corresponding to the input temperature are calculated (step S98) from the following formula using the color curve value S:

$$xc = T - (x - T\_len) \bullet (x + T\_len) \times S$$

wherein, T is a predetermined temperature, x is a temperature which is substituted for medium temperature, T_len is a range of temperature, and S is the slope of the temperature curve.

When the coordinates of xc corresponding to the predetermined temperature are obtained, color temperature data Rx, Gx, and Bx, corresponding to the predetermined temperature are calculated. The data is obtained using the following formulas:

$$Rx = (Rmin \times (T\_MAX-xc) + Rmax \times (xc-T\_MIN))/(T\_MAX-T\_MIN)$$

$$Gx = (Gmin \times (T\_MAX-xc) + Gmax \times (xc-T\_MIN))/(T\_MAX-T\_MIN)$$

$$Bx = (Bmin \times (T\_MAX-xc) + Bmax \times (xc-T\_MIN))/(T\_MAX-T\_MIN)$$

wherein, the calculated color temperature data, Rx, Gx, and Bx, are digital signals. The color temperature data (Rx, Gx, and Bx) is converted onto R, G and B gain and cutoff data. That is, video signal gains and cutoff values (R_Gain, G_Gain, B_Gain, R_Cutoff, G_Cutoff and B_Cutoff) are calculated from the values, T_MIN and T_MAX, according to the temperature which is input to microprocessor 20 in steps S95 or S96. The gain and cutoff values are obtained (step 99) using the following formulas:

$$\text{R-Gain} = (\text{Rmin} \times (\text{T\_MAX-xc}) + \text{Rmax} \times (\text{xc-T\_MIN}))/(\text{T\_MAX-T\_MIN})$$

$$\text{G-Gain} = (\text{Gmin} \times (\text{T\_MAX-xc}) + \text{Gmax} \times (\text{xc-T\_MIN}))/(\text{T\_MAX-T\_MIN})$$

$$\text{B-Gain} = (\text{Bmin} \times (\text{T\_MAX-xc}) + \text{Bmax} \times (\text{xc-T\_MIN}))/(\text{T\_MAX-T\_MIN})$$

$$\text{R\_Cutoff} = (\text{Rmin} \times (\text{T\_MAX-xc}) + \text{Rmax} \times (\text{xc-T\_MIN}))/(\text{T\_MAX-T\_MIN})$$

$$\text{G\_Cutoff} = (\text{Gmin} \times (\text{T\_MAX-xc}) + \text{Gmax} \times (\text{xc-T\_MIN}))/(\text{T\_MAX-T\_MIN})$$

$$\text{B\_Cutoff} = (\text{Bmin} \times (\text{T\_MAX-xc}) + \text{Bmax} \times (\text{xc-T\_MIN}))/(\text{T\_MAX-T\_MIN})$$

The digital gain and cutoff values are converted into analog signals at step S100.

In step S101 the user determines whether the color displayed on the screen is the desired color. When the displayed color data meets what the user wants, the steps for calculating the gain and cutoff values are completed at step S103. However, if the displayed color data is not what the user wants, the procedure returns (S102) to the step S94 where the manual correction mode is selected by the user. Thus, steps S96 to S101 are repeated until color meeting the user's demand is obtained.

Consequently, the present invention adjusts colors displayed on a monitor using R, G and B gain and cut-off signals which change according to a color curve in a color space in order to adjust

colors as a user wants, thereby improving the color function which enables the user to easily adjust colors in the state he/she wants.

It will be apparent to those skilled in the art that various modifications and variations can be made in the color curve control circuit and method of the present invention without deviating from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A color curve control circuit comprising:

a data input unit, for entering values to change the colors on the screen of a video monitor;

a microcomputer, for processing color signals corresponding to color temperature using stored color temperature values and a color curve control program in order to change the colors on the screen according to signals received by the data input unit, and for generating color gain signals and color cutoff signals; and

a digital to analog converter for converting the digital color gain and cutoff signals from the microcomputer into analog signals.

2. The circuit according to claim 1, further comprising:

an on screen display unit, for generating on screen display signals describing a procedure of transmitting the display values from the data input unit to the microcomputer, and changing the colors on the screen using said display values; and

a multiplexer for selectively supplying the on screen display signals transmitted by the on screen display unit.

3. The circuit according to claim 1, wherein the data input unit comprises:

temperature sensing means, for automatically sensing ambient temperature of the monitor, and generating a temperature signal which automatically changes a color of the screen according to the temperature of the monitor; and

a keypad through which a user enters temperature values indicating a desired color to manually change the color of the screen.

ABSTRACT OF DISCLOSURE

A color curve control circuit includes: a data input unit, for entering values for changing colors on the screen of a monitor; a microcomputer, for processing color signals corresponding to color temperature using stored color temperature data and a color curve control program, in order to change the colors on the screen according to signals generated by the data input unit, and for generating color gain signals and color cutoff signals; and a digital to analog converter for converting the digital color gain and cutoff signals from the microcomputer into analog signals.

FIG. 1

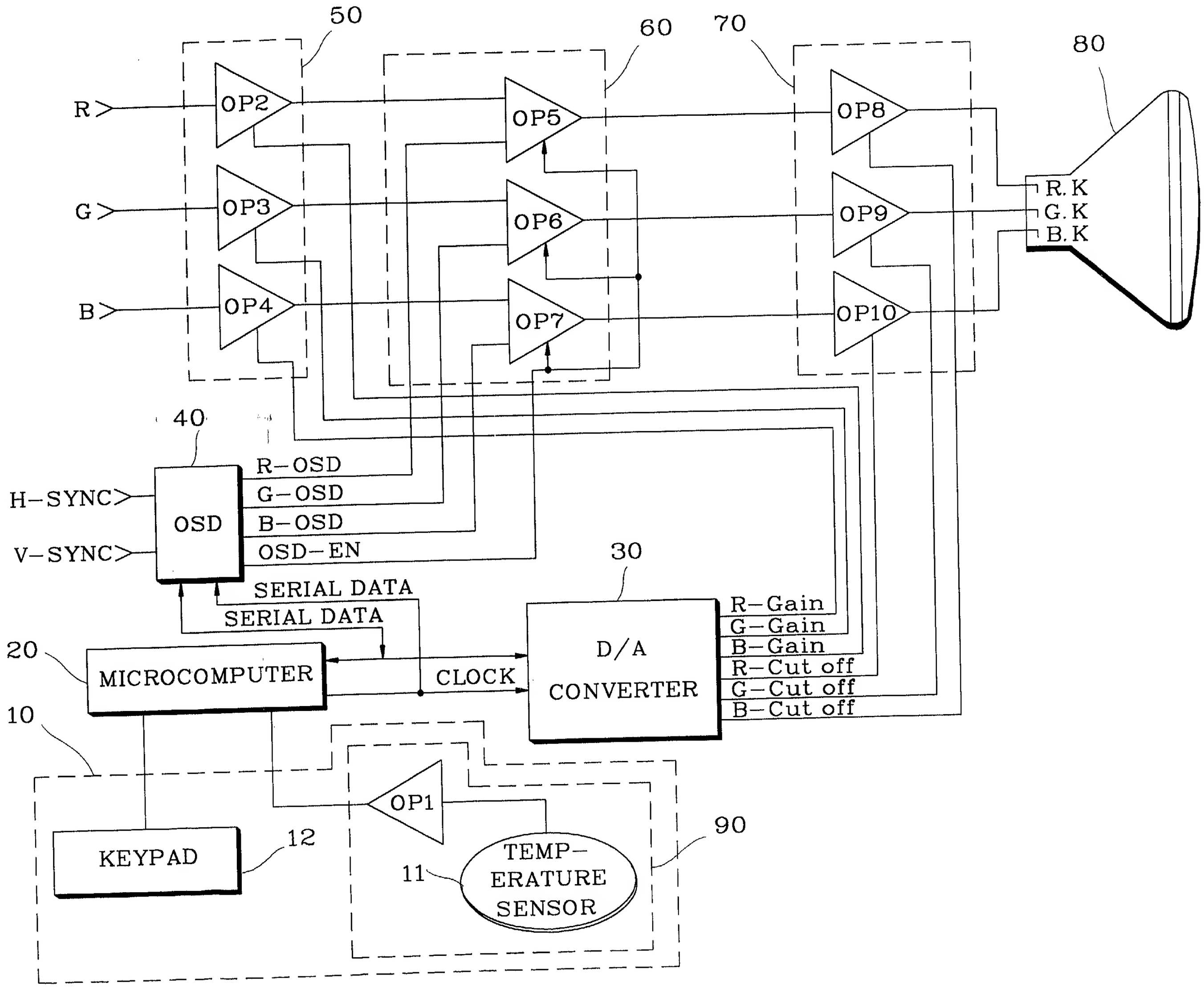


FIG. 2

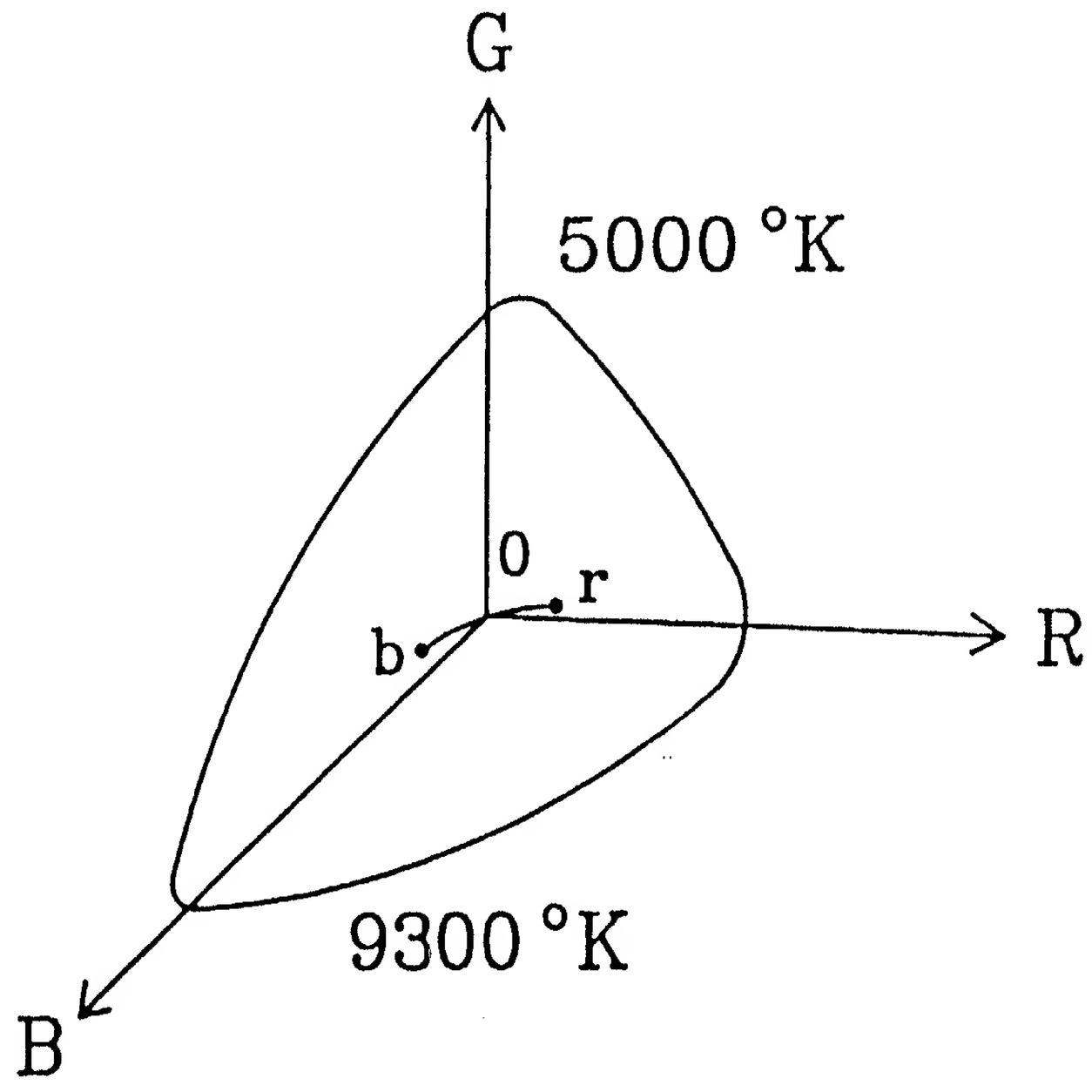
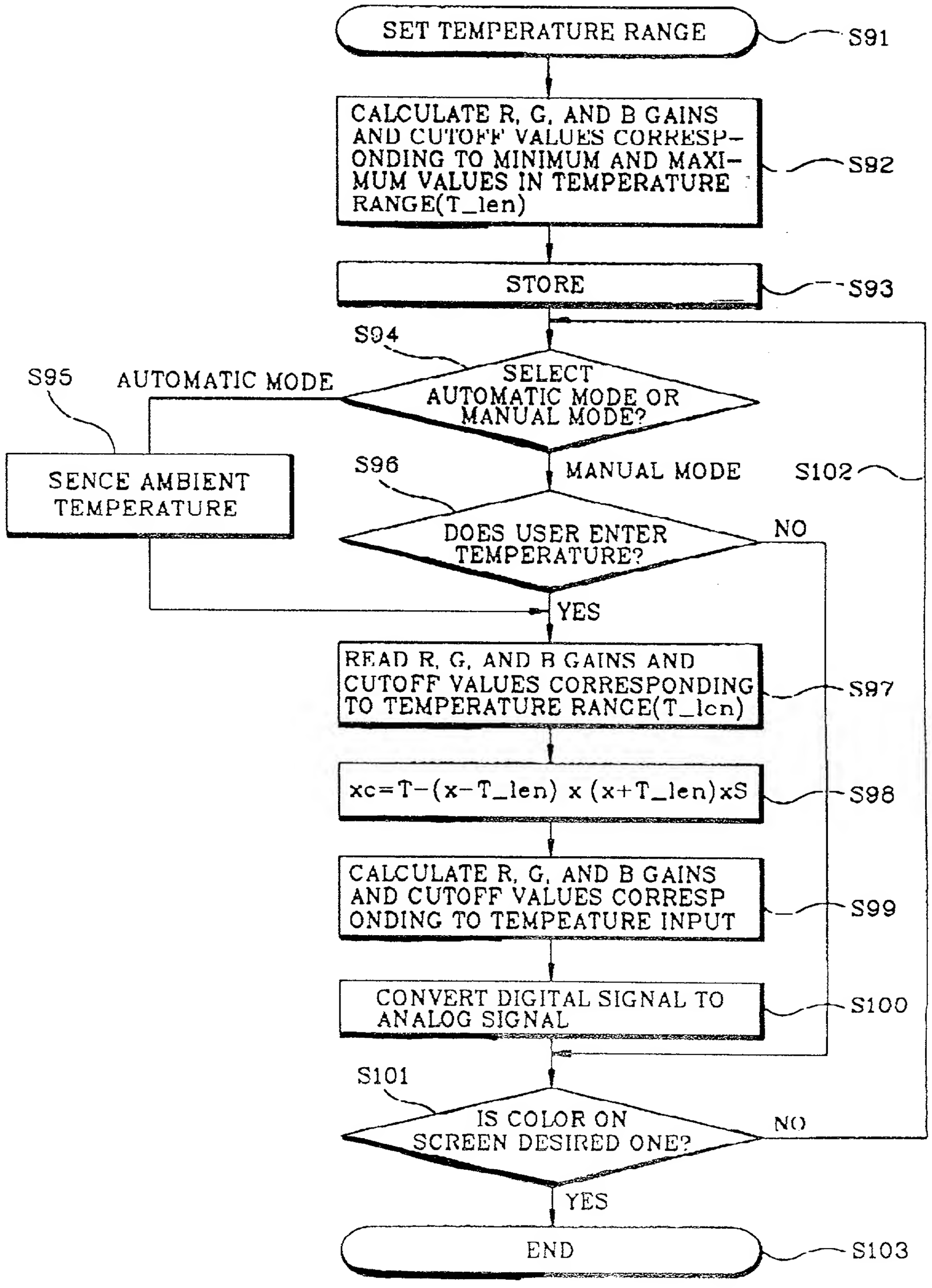


FIG. 3


SET TEMPERATURE RANGE
S91
CALCULATE R, G, AND B GAINS AND CUTOFF VALUES CORRESPONDING TO MINIMUM AND MAXIMUM VALUES IN TEMPERATURE RANGE(T_len)
S92
STORE
S93
S94
SELECT AUTOMATIC MODE OR MANUAL MODE?
S95
AUTOMATIC MODE
SENCE AMBIENT TEMPERATURE
S96
MANUAL MODE
S102
DOES USER ENTER TEMPERATURE?
NO
YES
READ R, G, AND B GAINS AND CUTOFF VALUES CORRESPONDING TO TEMPERATURE RANGE(T_len)
S97
xc=T-(x-T_len) x (x+T_len)xS
S98
CALCULATE R, G, AND B GAINS AND CUTOFF VALUES CORRESPONDING TO TEMPEATURE INPUT
S99
CONVERT DIGITAL SIGNAL TO ANALOG SIGNAL
S100
S101
IS COLOR ON SCREEN DESIRED ONE?
NO
YES
END
S103

PATENT
P54562

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Chun-Geun CHOI

Serial No.: *To be assigned* Examiner: *To be assigned*

Filed: 11 June 1997 Art Unit: *To be assigned*

For: COLOR CURVE CONTROL CIRCUIT AND METHOD

TRANSMITTAL OF DECLARATION

Assistant Commissioner
for Patents
Washington, D.C. 20231

Sir:

This transmittal accompanies a Declaration without the signature by the inventor, for the above-captioned application. A Substitute Declaration with the inventor's signature will be filed upon receipt of the Serial No. for the above-captioned application.

Respectfully submitted,

Robert E. Bushnell,
Attorney for the Applicant
Registration No.: 27,774

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Folio: P54562
Date: 06/11/97
I.D.: REB/mf

PTO/SB/01 (6/95)

DECLARATION

Docket No. P54562

AS A BELOW NAMED INVENTOR, I hereby declare that:
My residence, post office address and citizenship are as stated next to my name.
I believe that I am the original, first and sole (*if only one name is listed below*), or an original, first and joint inventor (*if plural names are listed below*), of the subject matter which is claimed and for which a patent is sought on the invention entitled:

TITLE: COLOR CURVE CONTROL CIRCUIT AND METHOD

the specification of which either is attached hereto or otherwise accompanies this Declaration, or:

☐ was filed in the U.S. Patent & Trademark Office on _____ and assigned Serial No. _____.

☐ and (*if applicable*) was amended on _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability and to the examination of this application in accordance with Title 37 of the Code of Federal Regulations §1.56. I hereby claim foreign priority benefits under Title 35, U.S. Code §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT International application which designated at least one country other than the United States, or §119(e) of any United States provisional application(s), listed below and have also identified below any foreign applications for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

			Priority Claimed:
96-20847	Korea	11 June 1996	Yes [X] No [ ]
(Application Number)	*(Country)*	*(Day/Month/Year filed)*	
			Yes [ ] No [ ]
(Application Number)	*(Country)*	*(Day/Month/Year filed)*	
			Yes [ ] No [ ]
(Application Number)	*(Country)*	*(Day/Month/Year filed)*	

I hereby claim the benefit under Title 35, U.S. Code, §120, of any United States application(s), or §365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application(s) in the manner provided by the first paragraph of Title 35, U.S. Code, §112, I acknowledge the duty to disclose information material to patentability as defined in Title 37, The Code of Federal Regulations, §1.56(a) which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	*(Filing Date)*	*(STATUS: patented, pending, abandoned)*
(Application Serial No.)	*(Filing Date)*	*(STATUS: patented, pending, abandoned)*

I hereby revoke all previously granted powers of attorney and appoint the following attorneys: Robert E. Bushnell, Reg. No. 27,774 and Michael D. Parker, Reg. No. 34,973, to prosecute this application and to transact all business in the U.S. Patent & Trademark Office connected therewith and with any divisional, continuation, continuation-in-part, reissue or re-examination application, with full power of appointment and with full power to substitute an associate attorney or agent, and to receive all patents which may issue thereon, and request that all correspondence be addressed to:

Robert E. Bushnell,
Attorney-at-Law
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Washington, D.C. 20005-1401

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I HEREBY DECLARE that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 U.S. Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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FULL NAME OF FOURTH JOINT INVENTOR: _____ Citizenship: _____
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☐ Additional inventors are being named on separately numbered sheets attached hereto.